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(54) Remote control apparatus for machine tools

(57) A machine tool, in particular a grinding machine, is remotely controlled. As shown, the remote control apparatus is portable and has a keyboard 22, a microprocessor 47, and a display 23b. Commands are sent to the machine tool by a transmitter 26 of ultrasonic, infra-red or radio waves or by a data line coupled to a connector 24.

The apparatus may include a seismic sensor 53 for detecting stray movement of the machine tool, an acoustic alarm 28 and an acoustic sensor 54. A console has a first keyboard for controlling the machine tool and the remote control apparatus has a second keyboard 22 which can be used independently of the first keyboard. The console and the frame of the machine have depositories for the remote control apparatus; the first keyboard being automatically deactivated when the remote control apparatus is removed from a depository and vice versa.

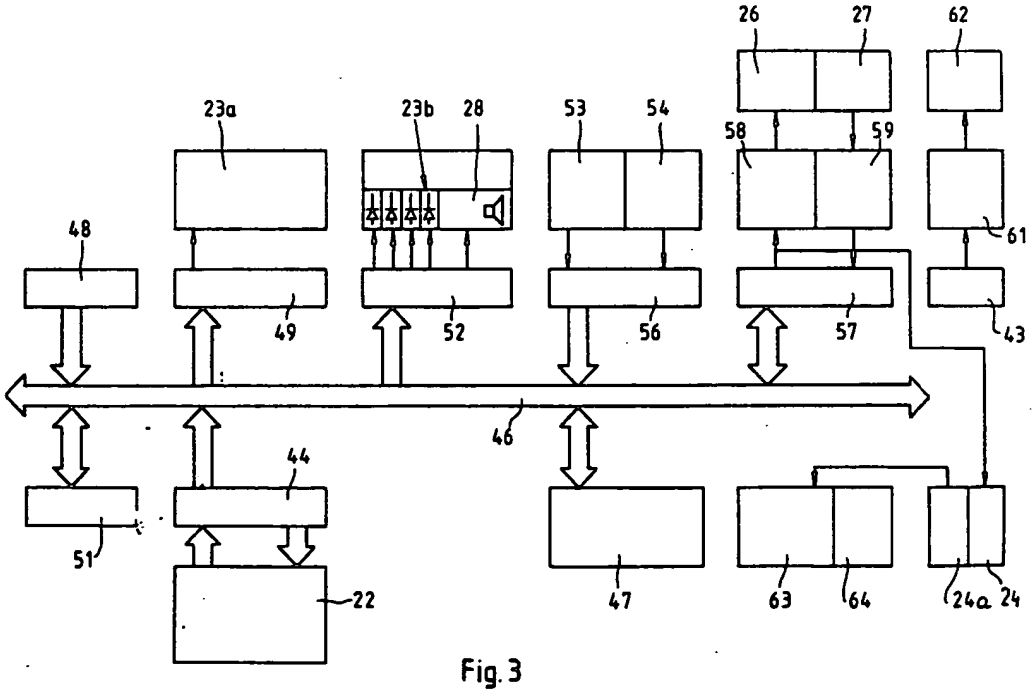

Fig. 3

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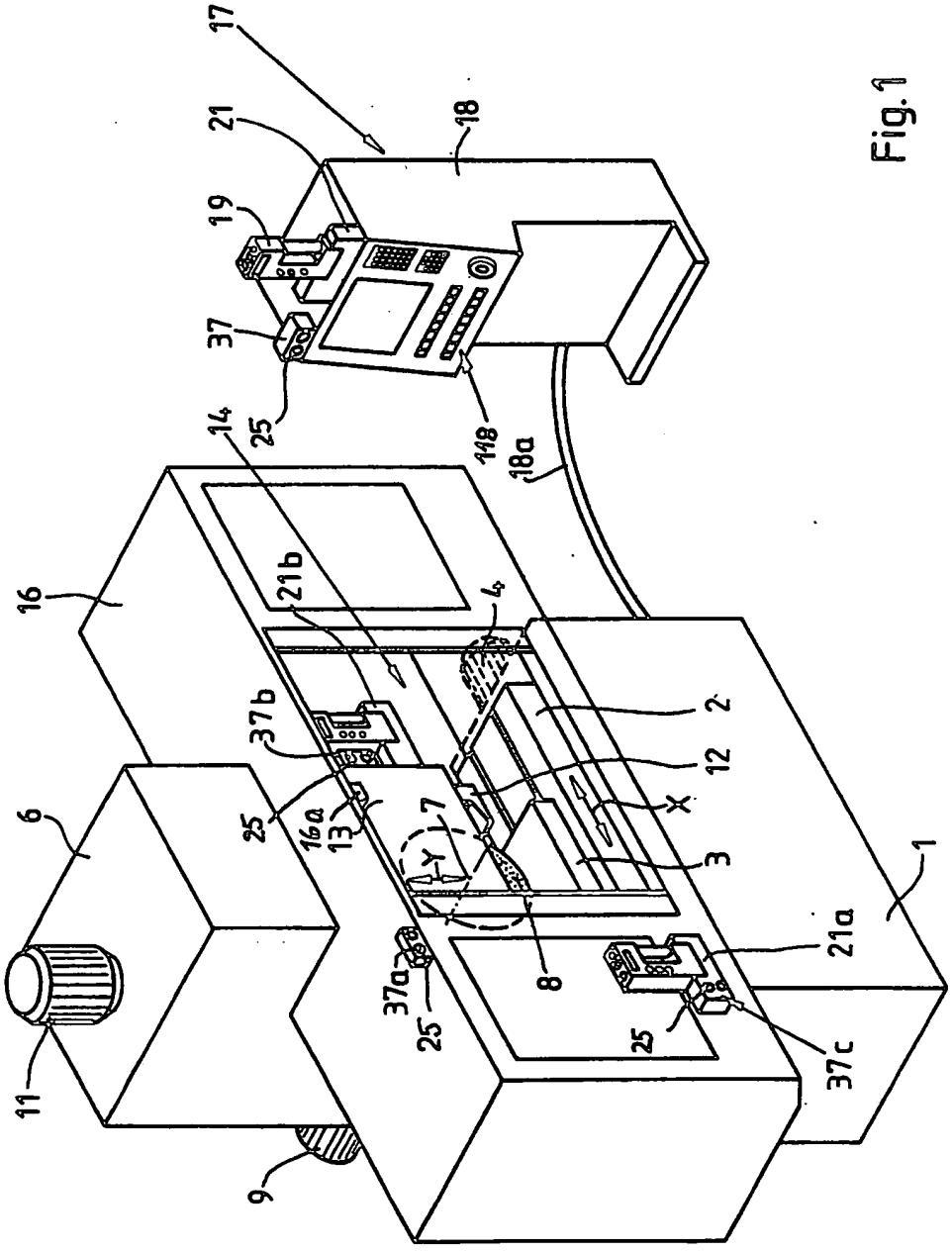

Fig.1

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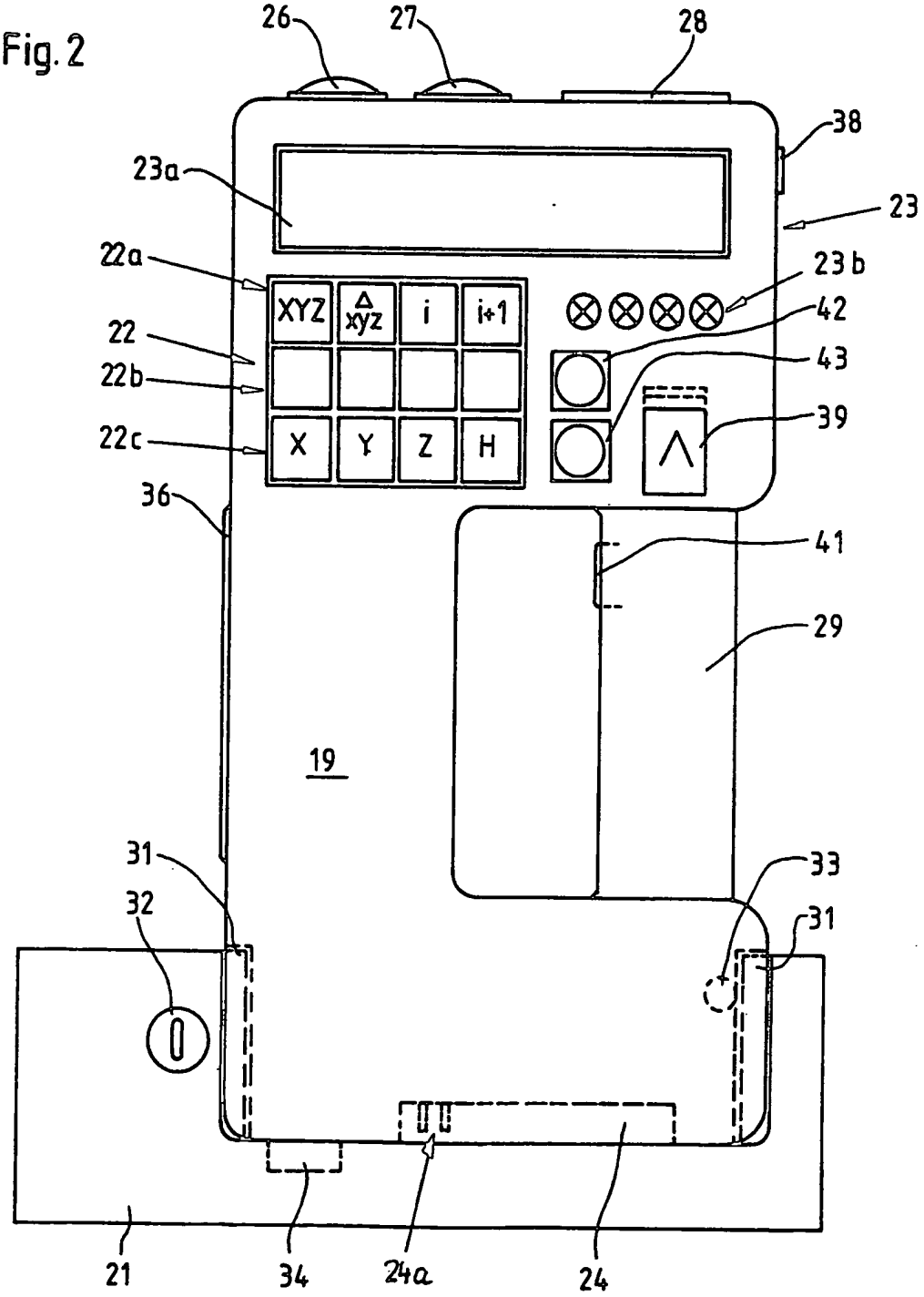
Fig. 2



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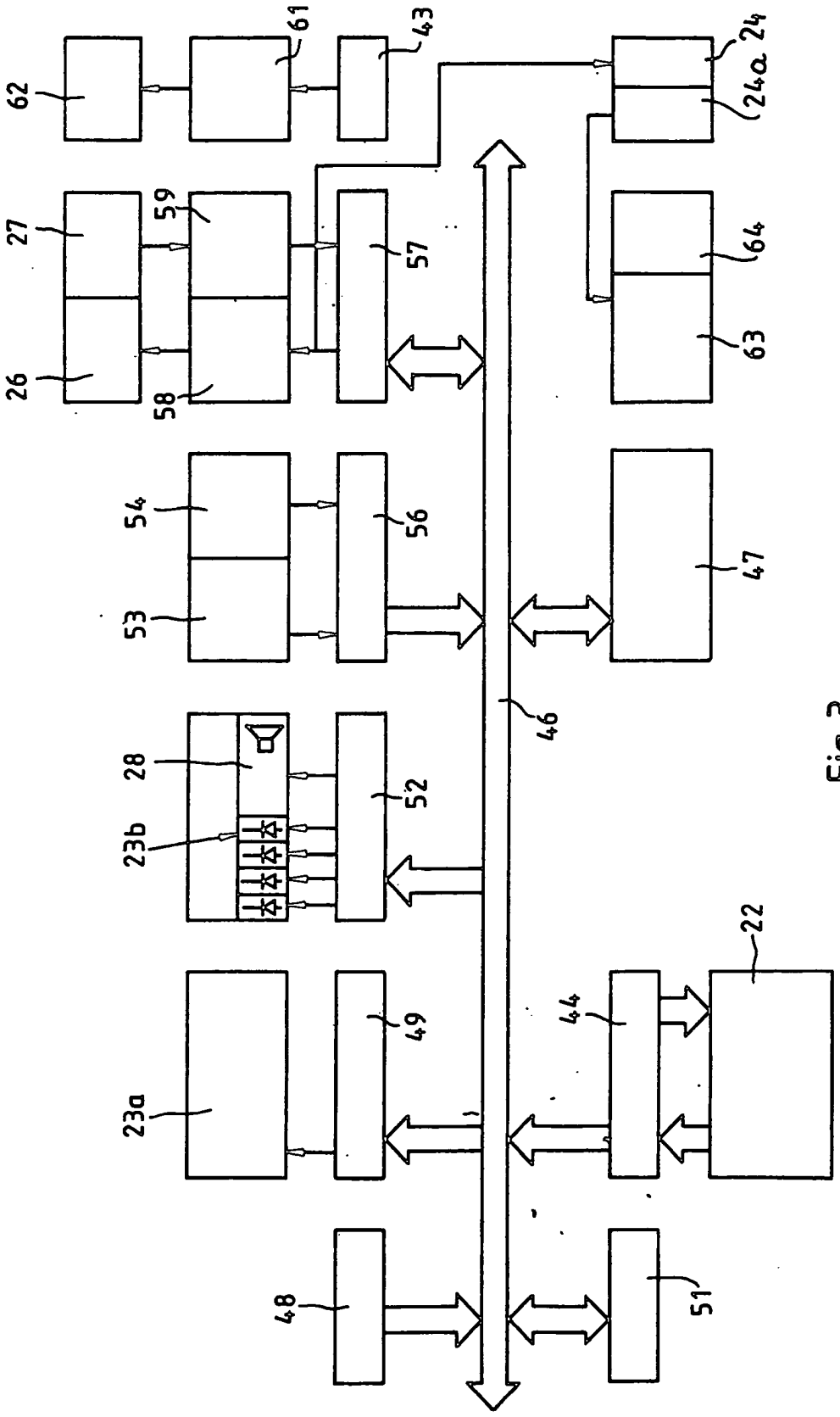

Fig. 3

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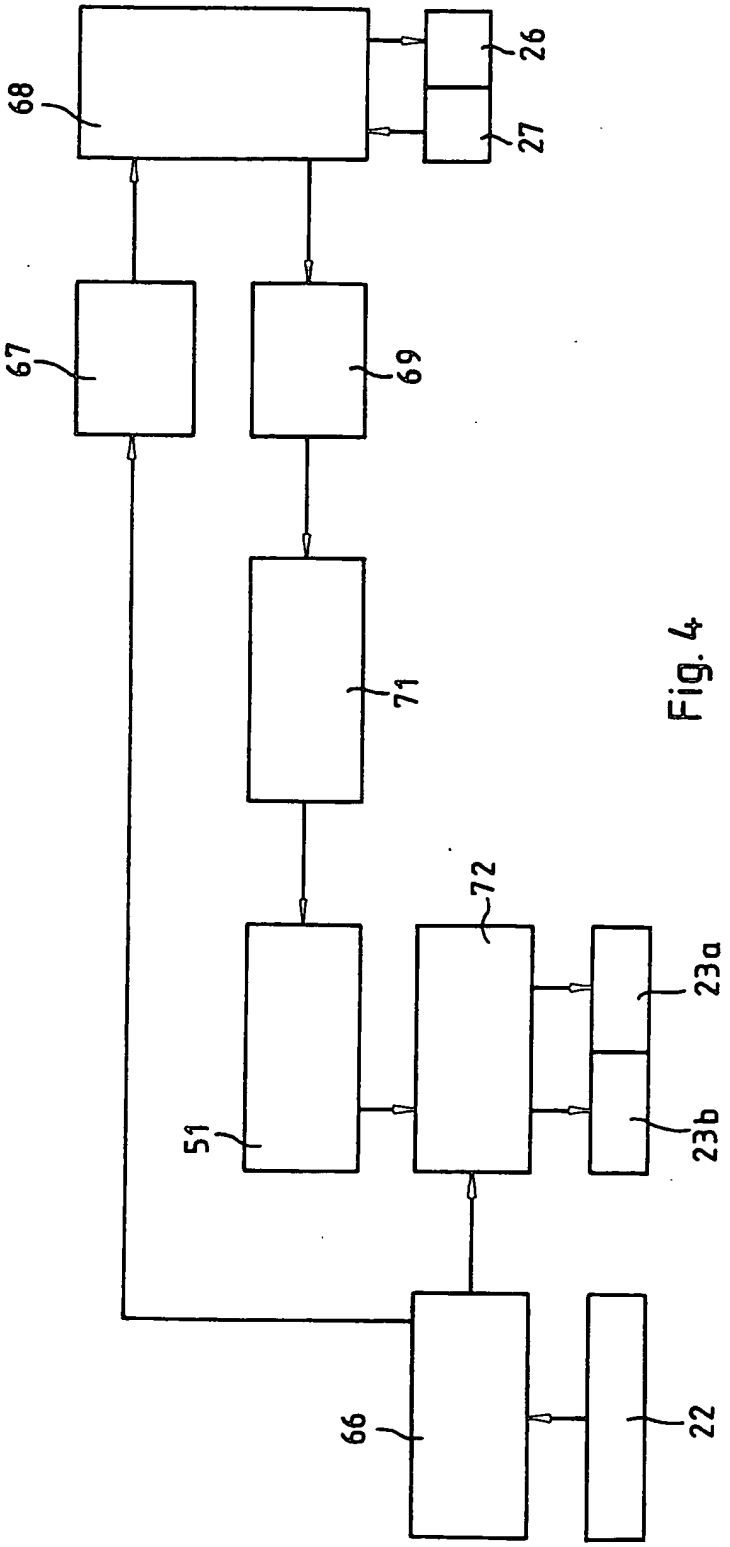

Fig. 4

REMOTE CONTROL APPARATUS FOR MACHINE TOOLS

The invention relates to improvements in machine tools, and more particularly to improvements in automated machine tools, e.g., numerically or otherwise controlled grinding machines. Still more particularly, the invention relates to improvements in machine tools (hereinafter called grinding machines with the understanding, however, that the invention can be embodied with equal or similar advantage in milling, lapping, nibbling and many other machines) of the type wherein one or more drive means (e.g., variable-speed reversible or non-reversible electric motors) are operable to carry out a plurality of functions, such as rotating a tool (e.g., a single grinding wheel or a cluster of two or more grinding wheels) at one or more speeds, moving a slide for the tool and its carrier (such as a spindle for one or more grinding wheels) relative to the work holder or work holders, moving one or more work holders relative to the frame of the grinding machine, actuating the device or devices which separably clamp a workpiece to its holder, and others.

Machines of the above outlined character are normally provided with means for controlling the operation of one or more drive means, i.e., for selecting, initiating and/or terminating or interrupting at least one of the aforediscussed functions of the drive means. Problems arise when one or more movable components of the grinding machine (such as the spindle and/or the grinding wheel or wheels thereon, the dressing tool or tools for the grinding wheel(s), the slide for the spindle and/or the work holder or holders) are accessible at the working station by opening a door which normally prevents access to the working space in order to prevent injury to attendants and/or to prevent

coolant, lubricant and/or fragments of removed material from contaminating the surrounding area. For example, the working space should be accessible to one or more operators when the setup of the machine is to be changed preparatory to treatment of a series of different workpieces or preparatory to treatment of the same or different workpieces by one or more different grinding wheels. The operator or operators in charge can cause one or more drive means to initiate certain movements of one or more movable components by depressing or touching the corresponding key or keys on the keyboard of the console which is adjacent the grinding machine proper and is connected with the machine by one or more electric cables. As a rule, the console is located in front of the machine and the support for its keyboard can be rotatably mounted on a suitable pedestal. Thus, if an operator places herself or himself in front of the working space to observe one or more components in the working space, the console and its keyboard are invariably disposed behind such operator. In other words, if the operator wishes to observe the component or components in the working space, such person cannot simultaneously look at the keyboard of the console and vice versa. This can involve serious danger to the operator because the operator is likely to miss the proper key on the keyboard of the console and depress or otherwise actuate another key which is likely to initiate an abrupt angular, translatory or other movement of one or more components in the working space while the operator is sufficiently close to such component or components to be likely to suffer a serious injury.

It was already proposed to install manually operable wheels at the front side of a numerically controlled grinding machine and to establish proper

connections between such wheels and the work holder and/or grinding spindle. Thus, the operator who places herself or himself into close or immediate proximity of the working space can initiate certain movements of the components in the working space by manipulating the corresponding wheel or wheels instead of being compelled to reach behind her or his body in order to initiate certain operations from the keyboard of the console. This simplifies the task of the operator and reduces the likelihood of injury because the operator is in a position to simultaneously observe the working space and the set of wheels at the front side of the grinding machine. However, such proposal also exhibits serious drawbacks, especially as concerns the versatility of the machine. The wheels are designed to move certain components in the working space in two directions only. Reference may be had to German Offenlegungsschrift No. 36 25 043.

The invention is embodied in a machine tool, particularly in a grinding machine, which comprises a plurality of drive means operable to carry out a plurality of functions (such as rotating the spindle for the grinding wheel or wheels at one or more speeds, shifting the work holder or work holders relative to the frame of the machine tool, moving the grinding wheel and its spindle relative to the work holder, moving a dressing tool toward and from engagement with a grinding wheel, rotating the dressing tool and/or others). In accordance with a feature of the invention, the machine tool comprises means for controlling the operation of the drive means in carrying out at least some of the functions, and the controlling means comprise at least one remote control apparatus having sender means and input means (such as a keyboard) arranged to receive information including commands and data and to transmit such information to the sender means, and means for conveying information between the sender means and at least one of the drive means. As mentioned above, the mobile components which can receive motion from the drive means can include a spindle or an analogous tool carrier, one or more work holders, and a slide for the tool carrier. The machine tool and/or the controlling means can include means for separably supporting the remote control apparatus.

The sender means can include a wireless

transmitter, and the conveying means can include a receiver of information from the wireless transmitter. Alternatively, the sender means can include a plug-in transmitter, and the conveying means then includes at least one plug-in receiver of information. The controlling means of such machine tool further comprises conductor means connecting the transmitter with the receiver. The conductor means can comprise a data line.

The remote control apparatus is or can be sufficiently compact to be held by hand, for example, to be held by one hand while the other hand is used to actuate the keyboard (input means) of the remote control apparatus.

The machine tool further comprises a console, a frame for the drive means, and means for separably attracting the remote control apparatus to the frame or to the console. The attracting means can comprise at least one magnet, e.g., a magnet which is provided on the remote control apparatus.

The remote control apparatus can further comprise a display device for information which is selected by the input means.

The controlling means can further comprise at least one data transmitting second sender means, and the remote control apparatus then comprises receiver means for data from the second sender means. The remote control apparatus of such controlling means preferably comprises an interface or other suitable means for transmitting data from the receiver means to the display device of the remote control apparatus. The aforementioned frame or housing defines at least one working chamber or space for one or more mobile components which are connected with one or more drive means of the machine tool, and the second sender means can be disposed in or close to the working chamber. The

aforementioned information conveying means, too, can be located in or close to the working chamber. Moreover, the machine tool can comprise at least one holder means for the remote control apparatus, and such holder means can be installed in or close to the working chamber to removably receive and hold the remote control apparatus.

The frame can include a door which is movable between operative and inoperative positions in which the working chamber is respectively closed (e.g., sealed) and accessible, and the machine tool can comprise means for preventing the transmission of at least some information between the remote control apparatus and the conveying means in the inoperative position of the door. For example, the arrangement can be such that, when the door is open and the movable component or components in the working space are accessible, the preventing means ensures that the drive means cannot rotate and/or otherwise move the respective mobile component or components above a certain speed or beyond a predetermined (limited) extent to thus reduce the likelihood of injury to an attendant at the open door.

The aforementioned console of the controlling means can include its own keyboard or keyboards or analogous means for influencing the drive means independently of the remote control apparatus, and the controlling means can further comprise means for deactivating the influencing means on the console when the conveying means receives information from the remote control apparatus. This ensures that at least some signals from the influencing means cannot interfere with some or any of the signals from the remote control apparatus and vice versa.

The controlling means can further comprise means for preventing the drive means from carrying out at least one of the functions when the conveying means

receives information from the remote control apparatus.

As mentioned above, the console can comprise holder means for separably supporting the remote control apparatus, and such console can further comprise or carry means for preventing the transmission of information between the remote control apparatus and the conveying means when the apparatus is carried by the supporting means, i.e., the remote control apparatus is then incapable of interfering with the operation of the machine tool in response to signals from the influencing means forming part of or installed on or in the console.

The input means, the sender means and the conveying means are preferably arranged to transmit coded information which is characteristic of the controlling means. This ensures that the remote control apparatus which is part of the controlling means in a first machine tool cannot interfere with the operation of other machine tools and vice versa.

The aforementioned holder means of the console can be equipped with means for at least partially deactivating the influencing means of the console when the remote control apparatus is inserted into or is otherwise supported by the holder means, and for preventing the transmission of at least some information between the remote control apparatus and the conveying means when the remote control apparatus is removed from the holder means. The arrangement may be such that the remote control apparatus is completely deactivated when it is supported by the holder means. When the remote control apparatus is detached from (e.g., lifted off) the holder means of the console, the influencing means can be deactivated, either entirely or in part, so that the remote control apparatus then constitutes the only means for regulating the operation of the drive means.

The holder on the console can constitute one

of two, three or more depositories for the remote control apparatus. The conveying means of the controlling means in such machine tool can include an information conveying unit which is associated with each of the depositories and separable plug-in connections between the remote control apparatus and each such unit. Each of the plug-in connections can comprise a female connector and a male connector. One of these connectors is provided on the remote control apparatus and another of these connectors is provided on each of the depositories for the remote control apparatus.

At least one of the depositories can be provided with means for connecting a battery or other suitable rechargeable energy storing means of the remote control apparatus with a suitable energy source.

The remote control apparatus can further comprise means for generating and transmitting acoustic signals, and seismic sensor means for detecting stray movements of the machine tool (e.g., when a tool (such as a grinding wheel) strikes a workpiece). Still further, the remote control apparatus can comprise means for receiving and processing acoustic signals. For example, at least one of the drive means can be arrested in response to transmission of a processed acoustic signal and/or in response to a properly processed signal which is detected by the seismic sensor means of the remote control apparatus.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved remote control apparatus itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with

reference to the accompanying drawing.

FIG. 1 is a perspective view of a grinding machine with a controlling means embodying one form of the invention;

FIG. 2 is an enlarged front elevational view of the remote control apparatus of the controlling means and of a depository for the remote control apparatus;

FIG. 3 is a block diagram of those parts of the controlling means which are installed in or are mounted on the casing of the remote control apparatus; and

FIG. 4 is a block diagram showing certain elements of the remote control apparatus and certain additional elements of the controlling means.

FIG. 1 shows a machine tool which constitutes a grinding machine and embodies a controlling means 17 (hereinafter control unit for short) which is constructed in accordance with the present invention. The frame or housing of the machine comprises a base or bed 1 for a table 2 constituting a work holder and being movable in directions of the X-axis, namely at right angles to the axis of a grinding wheel 8 on a grinding spindle 7 which is indicated by a phantom line. The means for releasably clamping a workpiece 3 to the work holder 2 is not shown in the drawing. The drive means for moving the table 2 in directions of the X-axis is shown at 4; such drive means can include a variable-speed reversible electric motor of any known design.

The frame of the grinding machine further comprises an upright frame member 6 for a slide or carriage (not specifically shown) which supports the spindle 7 for the grinding wheel 8 and is movable up and down in directions of the Y-axis by a second drive means 11. A third drive means 9 is mounted on the aforementioned slide or carriage and serves to rotate the spindle 7 and the grinding wheel 8 about their common axis. FIG. 1 further shows a nozzle 12 which serves to direct a spray of coolant and/or lubricant into the area where the grinding wheel 8 engages and removes material from the workpiece 3 on the table 2. The frame further includes a housing 16 which defines a working space or chamber 14 for the table 2, workpiece 3, spindle 7 and grinding wheel 8. The housing 16 has a door 13 which is slidable or otherwise movable between an operative position in which the working space 14 is closed from the surrounding atmosphere and an inoperative position in which the mobile components 2,

3, 7, 8 in the working space 14 are accessible to an attendant in front of the housing 16.

The control unit 17 includes a console 18 with a keyboard 118 serving as a means for influencing the functions of the drive means 4, 9 and 11 in normal operation of the grinding machine. The console 18 is connected with the grinding machine proper by a conductor means 18a in the form of a flexible cable constituting a data circuit or data line. The console 18 is mounted in the customary way adjacent one side or directly in front of the housing 16, depending on the availability of space and/or upon other considerations.

In accordance with a feature of the invention, the control unit 17 further comprises a portable remote control apparatus 19 which is normally held in a depository or holder 21 on top of the housing of the console 18 and the details of which are shown in FIG. 2. Additional holders or depositories for the remote control apparatus 19 are provided on the housing 16 of the grinding machine; these include a holder 21a outwardly adjacent the opening which is exposed when the door 13 is held in the inoperative position, and a holder 21b which is installed in the working space 14 and is thus accessible only when the door 13 is caused to assume its inoperative position. It is clear that the grinding machine can be provided with additional holders or depositories for the remote control apparatus 19 and/or that at least one of the depositories or holders 21, 21a, 21b can be installed at a location other than those shown in FIG. 1.

As can be seen in FIG. 2, the remote control apparatus 19 comprises a casing which supports input means 22 including a keyboard with several rows and other arrays of actuating elements (hereinafter called keys) serving to introduce into the remote control

apparatus 19 information including commands and/or data to be transmitted to the drive means 4, 9 and/or 11 in or on the frame of the grinding machine. The casing of the remote control apparatus 19 further supports a composite display device 23 including a screen 23a and a set of lamps 23b. A plug-in connection 24 on the casing of the apparatus 19 serves to connect the casing with a source of data to be transmitted to the drive means 4, 9 and/or 11 and/or to be displayed at 23a and/or 23b. Another plug-in connection 24a serves to connect a rechargeable battery 64 (FIG. 4) or other suitable rechargeable energy storing means of the apparatus 19 with a suitable source of electrical energy. The casing of the apparatus 19 further carries a sender 26 and a receiver 27 for wireless transmission of information between the remote control apparatus 19 of the control unit 17 and the controls on and in the frame of the grinding machine. Still further, the apparatus 19 is provided with a loudspeaker-microphone combination 28 for transmission and reception, respectively, of acoustic signals.

The casing of the apparatus 19 includes a handle 29 which enables the operator to cause the drive means 4, 9 and/or 11 to perform one or more selected functions in response to signals which are generated as a result of manipulation of the apparatus 19 by the hand which grips the handle 29. The holder 21 on the console 18 is provided with a pair of spaced-apart parallel guide means 31 cooperating with complementary guide means on the casing of the apparatus 19 when the latter is properly deposited in (i.e., inserted into) the holder 21. A safety lock 32 is provided on the holder 21 and can be actuated by a key (not shown) to prevent unauthorized detachment of the apparatus 19 from the holder 21.

A deactivating means 33 in or on the holder 21 and/or in or on the casing of the apparatus 19 prevents transmission of some or any information between the apparatus 19 and the drive means 4, 9 and/or 11 when the casing of the apparatus 19 is properly deposited in the holder 21. The deactivating means 33 becomes ineffective (i.e., it can no longer interfere with transmission of information between the apparatus 19 and the drive means 4, 9, 11 in the frame of the grinding machine) when the casing of the apparatus 19 is detached from the holder 21. A second deactivating means 34 in or on the holder 21 and/or in or on the casing of the apparatus 19 prevents the keyboard 118 and/or other parts in or on the console 18 from influencing one or more functions of the drive means 4, 9 and/or 11 in response to detachment of the apparatus 19 from the holder 21. The arrangement may be such that all functions of the drive means 4, 9, 11 can be controlled by the keyboard (influencing means) 118 when the casing of the apparatus 19 is properly deposited in the holder 21, and that all functions of the drive means 4, 9, 11 can be controlled by the apparatus 19 when the latter is detached from the holder 21.

The casing of the apparatus 19 is further provided with a magnet 36 which serves as a means for separably attracting the casing to any selected magnetizable part of or on the frame of the grinding machine and/or to any magnetizable part of or on the console 18.

The means for conveying information between the remote control apparatus 19 and the drive means in the frame of the grinding machine without resorting to conductors includes a coupling device 37 which is a combined sender and receiver and is mounted on top of the console 18. Three additional information conveying

coupling devices 37a, 37b, 37c are mounted in the frame of the grinding machine. As can be seen in FIG. 1, the coupling device 37a is mounted on the housing 16 at a level above the holder 21a, the coupling device 37b is mounted in the working space 14, and the coupling device 37c is installed in the region of the holder 21a. Each of the coupling devices 37, 37a, 37b can be installed in or on one of the holders 21, 21a, 21b. As shown in FIG. 1 merely by way of example, the coupling device 37c is actually installed in or is combined with the holder 21a.

FIG. 1 further shows a device 16a which serves to deactivate the remote control apparatus 19 when the door 13 is held in the operative position so that it prevents access to the working space 14. The device 16a constitutes an optional but desirable and advantageous feature of the control unit 17. It ensures that the apparatus 19 can be put to use (e.g., during a change of setup of the grinding machine) only and alone when the door 13 is moved to its inoperative position so that the attendant or attendants can gain access to the working space 14 and to mobile components in such space. The device 16a is one of several safety features (the others include the aforediscussed deactivating means 33, 34, a starting switch 38, an activating switch or key 41 and a motion initiating switch or key 39) which are preferably installed in the grinding machine in addition to an emergency stop or turn-off switch 43 to reduce or eliminate the danger of injury to attendants.

The mode of operation of the control unit 17 including the remote control apparatus 19 is as follows:

The person in charge actuates the safety lock 32 so as to permit separation of the remote control apparatus 19 from the holder 21 on the console 18. Such separation of the apparatus 19 from the holder 21

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The person in charge actuates the safety lock 32 so as to permit separation of the remote control apparatus 19 from the holder 21 on the console 18. Such separation of the apparatus 19 from the holder 21

automatically induces the deactivating means 34 to limit the ability of the influencing means 118 and of the apparatus 19 to influence certain functions of the drive means 4, 9 and/or 11. For example, the limitation can involve prevention of those operations which could result in serious injury to an attendant performing her or his duties in the region of the working space 14. Thus, the deactivating means 34 can automatically limit the ability of the influencing means 118 and/or of the remote control apparatus 19 to cause the drive means 4 to advance the table 2 faster than at a certain rather limited speed, to cause the drive means 11 to move the slide or carriage for the spindle 7 and grinding wheel 8 faster than at a certain rather limited speed, and to cause a further drive means (not specifically shown in FIG. 1) for the dressing tool to move above a predetermined speed. Furthermore, the deactivating means 34 can prevent the drive means 9 from rotating the spindle 7 (and hence the grinding wheel 8) above a predetermined rotational speed. This can practically eliminate the danger of serious injury to an attendant who is in charge of, for example, changing the setup of the grinding machine while the apparatus 19 still enables such attendant to cause the drive means 4, 9 and/or 11 to perform its function or functions for the purposes of permitting a change of setup. Thus, the attendant at the door 13 of the housing 16 can observe the mobile components in the working space 14 while holding the casing of the apparatus 19 with one hand so that the other hand remains free to perform work in or close to the working space 14. The deactivating means 33 can completely deactivate the influencing means 118 (while simultaneously activating the apparatus 19 to the extent which is determined by the deactivating means 34) when the casing of the apparatus 19 is detached from

(e.g., lifted out of) the holder 21 on the console 18.

The arrangement is preferably such that the person holding the casing of the apparatus 19 in one hand can in fact activate the apparatus so that the latter can influence the drive means 4, 9 and/or 11. Thus, the means 33 and/or 34 can prepare the apparatus 19 for influencing of the drive means, and the activating or starter switch 38 on the casing must be depressed and/or otherwise moved or barely touched in order to activate the apparatus 19. The operator then depresses or touches one or more keys in the row 22a of the keyboard 22 in order to select one or more mobile components in the working space 14 for future movement in the direction of the respective axis X, Y or Z. The selected movement is indicated on the screen 23a of the display device 23. Moreover, the operator can depress or touch the key i or $i+1$ to thereby select a particular immediately following or next following program. The data for indicating the selected functions originate in the controls of the grinding machine and are transmitted to the receiver 27 of the apparatus 19 from the senders 25 of the coupling devices 37-37c to be displayed on the screen 23a in response to depression or in response to mere touching of selected keys in the group or row 22a.

The keys in the group or row 22b serve to transmit starting or arresting signals to the drive means for the grinding wheel and dressing tool, to the means for supplying coolant and/or lubricant to the nozzle 12 and to the means for engaging or disengaging the device which clamps the workpiece 3 to the table 2.

The keys in the group or row 22c are selector switches for the machine axes X, Y, Z and an auxiliary axis H.

The key 39 on the casing of the apparatus 19 must be touched or depressed preparatory to movement of

a mobile component in the direction of the selected axis. The arrangement is preferably such that the operator holding the casing of the apparatus 19 must further depress the key 41 on the handle 29 in order to ensure that the movement of a component in the direction of the selected axis actually takes place, i.e., it is necessary to depress the key 39 simultaneously with the key 41. Thus, a movement in the direction of a selected axis must be preceded by depression of one of the keys in the row 22c, by subsequent depression of the key 39 and by simultaneous depression of the key 41. The operator can hold the apparatus 19 in one hand or the apparatus can be caused to adhere to a selected portion of the machine frame or to a selected portion of the console 18 by contacting the magnet 36 with a magnetizable part of the frame or console. Care should be taken to ensure that the sender 26 of the apparatus 19 can transmit signals to the receiver of a coupling device (37, 37a, 37b or 37c) in that position of the casing in which the latter is held by the magnet 36. In other words, it is necessary to establish proper circumstances for wireless transmission of information between the sender 26 of the remote control apparatus 19 and the receiver of at least one of the coupling devices 37-37c.

If the apparatus 19 is designed to be manipulated by one hand of the operator, the selected key of the row 22c must be depressed only once. Such depression must be followed by simultaneous depression of the keys 39 and 41. All this can be done by the fingers of the hand which holds the handle 29. If it is desirable to further enhance the safety of the operator while the operator is active in the region of the working space 14, the apparatus 19 can be designed for manipulation by two hands, for example, in such way that

the fingers of the hand holding the handle 29 press or touch the keys 39, 41 while a finger of the other hand simultaneously touches or presses the selected key of the row 22c. In other words, a movement in the direction of a selected axis will then take place only if one of the keys in the row 22c is depressed or touched simultaneously with the keys 39 and 41.

A further key, knob or switch 42 on the casing of the apparatus 19 will be actuated if the operator wishes to test or observe the selected sequence of operations or functions before such operations are actually carried out. Thus, the operator will touch or depress the key 42 simultaneously with the key $\underline{i}$ and/or $\underline{i}+1$. The selected function or functions are then observable on the screen 23a of the display device 23. In order to enable the drive means to actually carry out the selected program, the operator releases the key 42 and thereupon again presses or touches the key $\underline{i}$ and/or $\underline{i}+1$.

The reference character 43 denotes in FIG. 2 the aforementioned emergency stop or turn-off key or switch which is connected with the controls in or on the frame of the grinding machine by a discrete wireless connection (FIG. 3) to immediately arrest all drive means or to immediately arrest that drive means which is active at the time of depression or touching of the key 43.

The loudspeaker-microphone combination 28 of the remote control apparatus 19 generates acoustic warning signals under certain circumstances, for example, in response to unintentional movement of the door 13 to closed position, when the energy source 64 of the apparatus 19 must be recharged and/or others. Moreover, the combination 28 can serve to interrupt or interdict certain operations, or to shut down the entire

grinding machine, in response to reception of certain acoustic signals, e.g., a signal representing noise which develops when the grinding wheel 8 collides with the workpiece 3 in a manner which is not contemplated for proper treatment of the workpiece, or if the collision takes place at a time when the workpiece and the grinding wheel should not touch each other.

FIG. 3 is a block diagram of certain elements of the remote control apparatus 19. The keyboard 22 of the apparatus 19 is connected with a microprocessor 47 by way of an interface 44 and a microprocessor bus 46. The operating program for the microprocessor 47 is stored in a memory 48. The bus 46 is connected with the screen 23a of the display device 23 by an interface 49. The screen 23a can include several rows of liquid crystal display elements. A data memory 51 contains control data for the grinding machine; such data are processed by the microprocessor 47 and can be addressed, among others, for displaying at 23a through the medium of the interface 49. The microprocessor 47 is further connected with the lamps 23b and with the loudspeaker-microphone combination 28 by way of a control module (latch) 52 and the microprocessor bus 46.

A seismic sensor 53 and an acoustic sensor 54 are connected with the microprocessor 47 by way of an interface 56 and the bus 46. An input/output (I/O) module 57 processes the commands and data which are to be transmitted, and the processed commands and data reach the sender 26 by way of a sender module 58. Inversely, data which are received at 27 and are transmitted to the input/output module 57 via receiver module 59 are processed in the module 57 before they reach the bus 46 and the microprocessor 47 for further processing.

Transmission of data from the remote control

apparatus 19 to the coupling units 37a-37c of the grinding machine and to the coupling unit 37 of the console 18 can take place ultrasonically, by infrared radiation or via radio waves. The apparatus 19 and other constituents of the control unit 17 are attuned to each other in such a way that the apparatus 19 cannot be used to influence the operation of another grinding machine and vice versa. All that is necessary is to select a code which further ensures that only an authorized person who is familiar with the code can utilize the remote control apparatus 19 to influence the drive means of the respective grinding machine.

Information which is transmitted by the remote control apparatus 19 to influence the operation of the drive means 4, 9 and/or 11 is automatically checked for accuracy. If the transmission of information is unsatisfactory, it is automatically repeated and the display device 23 can be caused to furnish an indication if repeated transmission of information continues to be unsatisfactory.

FIG. 3 shows a discrete channel for shutting off the drive means 4, 9, 11 in the event of an emergency. Thus, the emergency stop key 43 is connected with a discrete sender 62 by a module 61.

It is further possible to provide a data transmission which is confined to conductor means, i.e., information from the apparatus 19 to the coupling devices 37-37a can takes place by way of electrical conductors. To this end, the aforementioned plug-in connector 24 is connected with the input/output module 57 and is provided with corresponding data terminals. Thus, when the apparatus 19 is inserted into or deposited on one of the holders 21, 21a, 21b, it can also control the operation of the drive means 4, 9, 11 by way of the plug-in connector 24 of the respective

holder.

The connector 24a which is shown in FIG. 3 is connected with a loading or charging circuit 63 which can charge the battery 64 or another suitable rechargeable energy storing means of the remote control apparatus 19.

Referring to FIG. 4, information (including commands and data) which is applied via input means (keyboard) 22 of the remote control apparatus 19 is processed in a keyboard interpreter circuit 66 and is stored in a sender buffer 67 before it can be converted into transmissible information by a communication module 68. The output of the communication module 68 is connected with the sender 26 of the apparatus 19. Information which is transmitted to the receiver 27 of the apparatus 19 is processed in the communication module 68 and is temporarily stored in an intermediate memory 69 prior to being processed into a virtual image in an imaging module 71. The virtual image is stored in the data memory 51. An indicating module 72 processes data which are selected in the memory 51 by the keyboard 22 of the apparatus 19 so that the thus processed data can be displayed at 23a or at 23b.

The electrical and electronic elements of the control unit 17 and its remote control apparatus 19 are commercially available parts.

An advantage of the control unit 17 is that the position or location of the console 18 and its keyboard 118 is of no consequence to the attendant in charge of changing the setup of the grinding machine because the attendant simply switches from transmission of data and commands via keyboard 118 to transmission of data and commands via keyboard 22 of the apparatus 19. The control unit 17 is particularly flexible if the connection between the apparatus 19 and the coupling

devices 37-37c is a wireless connection, i.e., if the sender 26 constitutes or includes a wireless transmitter and each of the coupling devices 37-37a includes means for wireless reception of information from the sender 26. This renders it possible to move the apparatus 19 to any one of a practically infinite number of different positions in each of which the apparatus 19 can be used to transmit information to the drive means 4, 9 and/or 11 and/or to additional drive means (e.g., to a motor which moves the dressing tool into engagement with or away from the grinding wheel 8). Thus, the position of the apparatus 19 need not be selected in dependency on the locations of the holders 21, 21a, 21b, 21c because the apparatus 19 can be moved to any position which is most convenient to the attendant or attendants in charge of changing the setup of the machine or of performing any other work that necessitates gaining access to or being active close to the working space 14 while the door 13 is maintained in the inoperative (open) position.

If the maker of the grinding machine prefers the transmission of information by way of conductors, the casing of the apparatus 19 and the holders 21-21b are equipped with the aforediscussed plug-in connectors. The plug-in connector or connectors of the holder 21 on the housing of the console 18 are electrically connected with the drive means in or on the machine frame by conductor means forming part of the data line 18a.

It has been found that a portable apparatus 19 is particularly convenient and practical for the accomplishment of various objects of the present invention, such as convenience of manipulation, the possibility to deposit the apparatus 19 at any desired locus, the possibility to operate the keyboard 22 and other controls on the casing of the apparatus 19 with

one hand, and the ability to separably attach the apparatus 19 (by means of the magnet 36 or in an analogous way) at any desired locus in or on the grinding machine. As mentioned above, the apparatus 19 can be temporarily deposited in or attracted to machine parts within or outside of the working space 14 as well as on the console 18.

The display device 23 on the casing of the remote control apparatus 19 also contributes to reliability and versatility of the control unit 17. Thus, all of the selected commands and data can be displayed prior to being transmitted to the drive means for mobile components of the grinding machine.

The provision of a coupling unit (37b) in the working space 14 further enhances the versatility of the control unit 17 and the convenience of carrying out a change of setup or any other operation or operations which necessitate access to the working space 14. Moreover, the person in charge can deposit the apparatus 19 in the holder 21b so that the apparatus is close at hand while the person in charge carries out certain types of work in or close to the space 14.

The loudspeaker-microphone combination 28 also constitutes an optional but desirable feature of the control unit 17. Thus, the loudspeaker can transmit acoustic warning signals when an attendant in the region of the exposed working space 14 is not in a position to look at the display device 23 so that such attendant cannot visually perceive those circumstances which might warrant rapid deactivation of all of the drive means and immediate departure from a locus close to the housing 16 and its working space 14. The aforediscussed seismic sensor 53 of the apparatus 19 can be used to avoid further damage to the machine, e.g., by preventing repeated collision of the grinding wheel 8 with the

workpiece 3.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic and specific aspects of my contribution to the art and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the appended claims.

CLAIMS

1. A machine tool, particularly a grinding machine, comprising a plurality of drive means operable to carry out a plurality of functions; and means for controlling the operation of said drive means in carrying out at least some of said functions, comprising at least one remote control apparatus having sender means and input means arranged to receive information including commands and data and to transmit such information to said sender means, and means for conveying information between said sender means and at least one of said drive means.

2. The machine tool of claim 1, further comprising a plurality of mobile components connected with said drive means and including at least one tool carrier, such as a rotary grinding spindle, and work holder means, and means for separably supporting said apparatus.

3. The machine tool of claim 1, wherein said sender means includes a wireless transmitter and said conveying means includes a receiver of information from said wireless transmitter.

4. The machine tool of claim 1, wherein said sender means includes a plug-in transmitter and said conveying means includes at least one plug-in receiver of information, said controlling means further comprising conductor means connecting said transmitter with said receiver.

5. The machine tool of claim 4, wherein said conductor means comprises a data line.

6. The machine tool of claim 1, wherein said apparatus is sufficiently compact to be held by hand and said input means comprises a keyboard.

7. The machine tool of claim 1, further comprising a console, a frame for said drive means, and means for separably attracting said apparatus to said frame or to said console.

8. The machine tool of claim 7, wherein said attracting means comprises at least one magnet.

9. The machine tool of claim 8, wherein said at least one magnet is provided on said apparatus.

10. The machine tool of claim 1, wherein said apparatus further comprises a display device for said information.

11. The machine tool of claim 1, wherein said controlling means further comprises at least one data transmitting second sender means and said apparatus comprises receiver means for data from said second sender means.

12. The machine tool of claim 11, wherein said apparatus further comprises a display device and means for transmitting data from said receiver means to said display device.

13. The machine tool of claim 11, further comprising a frame defining at least one working space, and at least one mobile component connected to at least one of said drive means and located in said space, said second sender means being disposed in or close to said space.

14. The machine tool of claim 1, further comprising a frame defining at least one working space, and at least one mobile component connected to at least one of said drive means and located in said space, said information conveying means being located in or close to said space.

15. The machine tool of claim 1, further comprising a frame defining at least one working space, at least one mobile component connected with at least one of said drive means and located in said space, and holder means for said apparatus in or close to said space, said apparatus being removable from and reattachable to said holder means.

16. The machine tool of claim 1, further comprising a frame defining at least one working space and including a door movable between operative and inoperative positions in which said space is respectively closed and accessible, at least one mobile component provided in said space and connected with at least one of said drive means, and means for preventing the transmission of at least some information between said apparatus and said conveying means in the inoperative position of said door.

17. The machine tool of claim 1, wherein said controlling means further comprises a console having means for influencing said drive means independently of said apparatus, and means for deactivating said influencing means when said conveying means receives information from said apparatus.

18. The machine tool of claim 1, wherein said controlling means further comprises means for preventing said drive means from carrying out at least one of said functions when said conveying means receives information from said apparatus.

19. The machine tool of claim 1, wherein said controlling means further comprises a console having means for influencing said drive means independently of said apparatus, said console further having holder means for separably supporting said apparatus and means for preventing the transmission of information between said apparatus and said conveying means when the apparatus is carried by said holder means.

20. The machine tool of claim 1, wherein said input means, said sender means and said conveying means are arranged to transmit coded information which is characteristic of said controlling means.

21. The machine tool of claim 1, wherein said controlling means further comprises a console having means for influencing said drive means independently of said apparatus, said console further having holder means for said apparatus and said apparatus being insertable into and removable from said holder means, said holder means comprising means for at least partially deactivating said influencing means when said apparatus is inserted into said holder means and for preventing the transmission of at least some information between said apparatus and said conveying means when said apparatus is removed from said holder means.

22. The machine tool of claim 1, wherein said controlling means further comprises a console having means for influencing said drive means independently of said apparatus; and holder means for said apparatus, said apparatus being insertable into and removable from said holder means and further comprising means for deactivating said apparatus when the latter is inserted into said holder means.

23. The machine tool of claim 22, wherein said controlling means further comprises means for at least partially deactivating said influencing means in response to removal of said apparatus from said holder means.

24. The machine tool of claim 1, further comprising a plurality of depositories for said apparatus, said conveying means comprising an information conveying unit associated with each of said depositories and separable plug-in connections between said apparatus and each of said units.

25. The machine tool of claim 24, wherein each of said plug-in connections comprises a female connector and a male connector, one of said connectors being provided on said apparatus and another of said connectors being provided on each of said depositories.

26. The machine tool of claim 1, further comprising at least one depository for said apparatus, said apparatus having rechargeable energy storing means and said depository having means for connecting said energy storing means with an energy source when said apparatus is kept in said depository.

27. The machine tool of claim 1, wherein said apparatus further comprises means for generating and transmitting acoustic signals.

28. The machine tool of claim 1, wherein said apparatus comprises seismic sensor means for detecting stray movements of the machine tool.

29. The machine tool of claim 1, wherein said apparatus includes means for receiving and processing acoustic signals.

30. The machine tool of claim 29, further comprising means for arresting at least one of said drive means in response to processed acoustic signals.

31. The machine tool of claim 1, wherein said apparatus comprises seismic sensor means for generating and processing signals denoting stray movements of the machine tool, and further comprising means for arresting at least one of said drive means in response to signals from said sensor means.

32. A machine tool, substantially as herein described with reference to the accompanying drawings.

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